Innovations in Ophthalmology

Vacuum-assisted cortex removal - A novel change to the tradition

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In developing countries, manual small-incision cataract surgery (MSICS) has surfaced as the cost-effective alternative to phacoemulsification. The Simcoe irrigation-aspiration cannula was developed nearly 40 years ago and is still the most frequently employed tool for cortex aspiration. Although it stands unsurpassed, here we attempt to introduce an addition to the existing Simcoe cannula to achieve a dynamic and controlled vacuum with the added advantage of less physical strain and an effective volume of aspiration. The vacuum-assisted cortex removal device is based on a simple spring action mechanism, where the relaxation of the spring pushes the plunger up and thereby generates a controlled vacuum.

Key words: Cortex aspiration, manual small-incision cataract surgery, Simcoe cannula, vacuum

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Cataract accounts for nearly 75% of the cases of avoidable blindness, and it is estimated that more than 90% of the world's visually impaired live in developing countries.[1] Manual small-incision cataract surgery (MSICS) is a cost-effective and financially viable option, popular in developing countries. It is commonly adopted because of its ability to achieve visual outcomes comparable to phacoemulsification with less complication rates.[1] In addition, the lower mean per-case surgical time and cost enhances productivity in resource-limited settings. The Simcoe cannula is still being widely used in some western countries even during phacoemulsification. Its legacy will leave a remarkable footprint in the sands of time in cataract surgery.

Here, we propose the vacuum-assisted cortex removal (VCR) device as an addendum to the existing Simcoe cannula with the intention of reducing physical stress and aspirating a larger volume of cortex in a single attempt.

Innovation

Design of the device

The VCR system consists of the traditional two-way Simcoe irrigation aspiration cannula with an additional coiled stainless-steel spring inserted on the plunger of the syringe. The Simcoe irrigation aspiration cannula has a curved thin wall shaft with a 0.3-mm anterior aspiration port and an irrigation port on the side. Continuous irrigation is achieved by connecting the irrigation tube to the Simcoe cannula. The aspiration port is connected to a 10-inch tubing, and the luer-lock adapter is attached to a 10cc syringe. [Fig. 1a].

Device assembly

The plunger and barrel of the 10cc syringe are first disassembled [Fig. 1b]. A calibrated coiled stainless-steel spring is inserted into the plunger [Fig. 1c]. To re-assemble the syringe, the black-colored rubber seal of the plunger, which slides up and down the barrel, is pushed into the cylindrical barrel with the spring *in situ* [Fig. 1d]. The 10cc syringe with the coiled spring *in situ* is held in the non-dominant hand, while the Simcoe cannula with the irrigation tube is held in the dominant hand. By pushing the plunger down with the thumb of the non-dominant hand and compressing the spring, the air inside the barrel is expelled out [Fig. 2a].

Surgical technique

With the spring in a state of compression, the Simcoe cannula is introduced into the anterior chamber. The thumb slowly releases the pressure on the flange of the plunger [Fig. 2b]. This causes the spring to slowly recoil and creates a controlled

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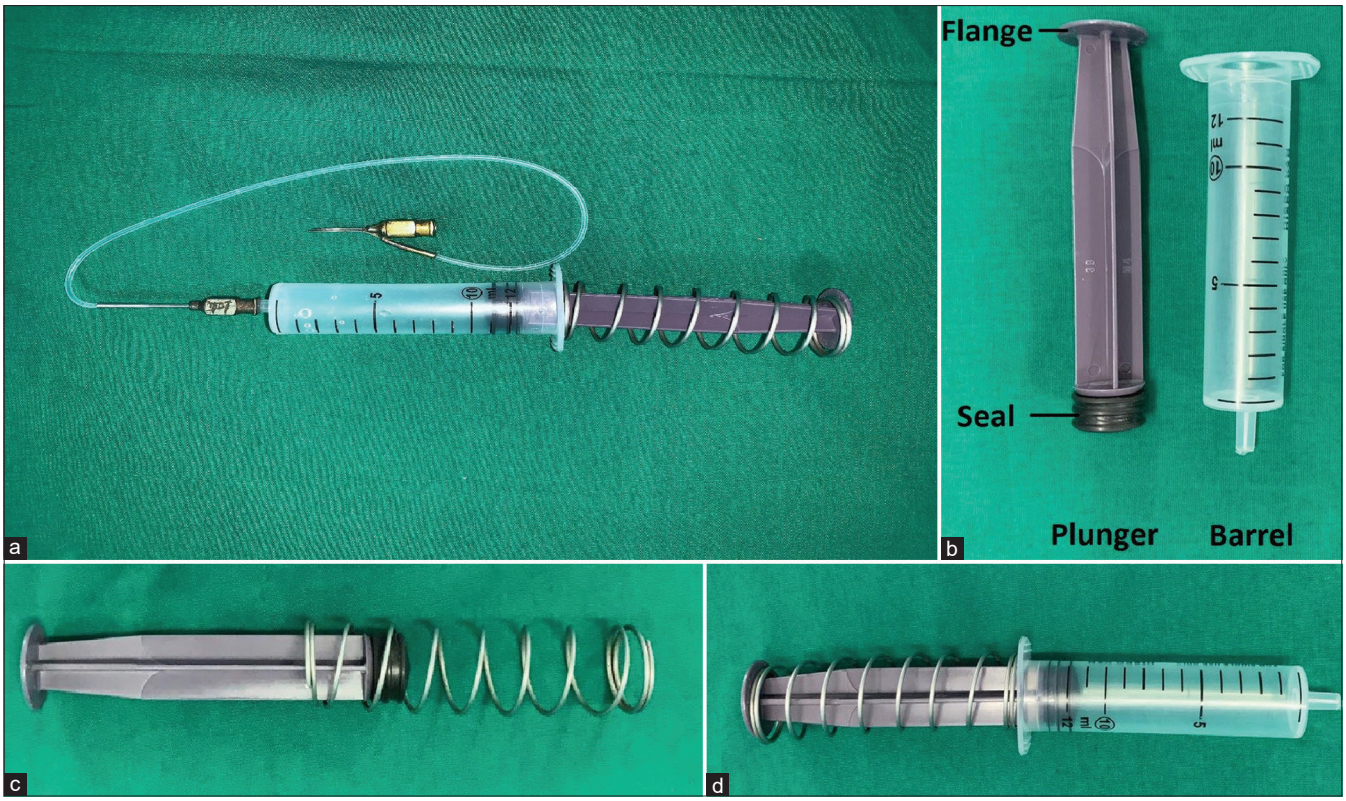

Figure 1: (a) The assembled vacuum-assisted cortex removal (VCR) system consisting of the traditional two-way Simcoe irrigation aspiration cannula with an additional coiled stainless-steel spring inserted on the plunger of the syringe. (b) The plunger and barrel of the 10cc syringe are disassembled. (c) A calibrated coiled stainless-steel spring is inserted into the plunger. (d) The plunger surrounded by the spring is pushed into the cylindrical barrel

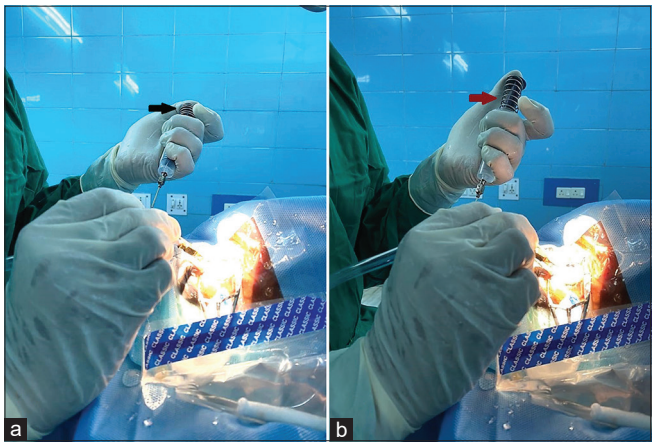

Figure 2: (a) The plunger is pushed down with the thumb of the non-dominant hand to compress the spring (black arrow), which expels the air inside the barrel. (b) The thumb slowly releases the pressure on the flange of the plunger, relaxing the spring (red arrow), which creates the necessary vacuum

vacuum that allows the cortical material to fill the port. It can then be manually stripped off of its attachments and aspirated. The amount of relaxation in the spring can be controlled manually to limit aspiration. Larger amounts of residual cortex or epinuclear sheet, including intact cortical bowls, can be brought to the center of the anterior chamber and aspirated rapidly by releasing the spring compression with ease.

Journey of the device

The idea of this device was conceived from the spring action syringe used in femtosecond laser surgeries to stabilize the globe. The same had earlier set the stage for spring-action apparatus for fixation of eyeball (SAFE) for wet-lab training.[2] Targeting an effortless and controlled vacuum for cortex aspiration, this spring action mechanism was attempted to be incorporated into the Simcoe cannula [Figs. 3 and 4].

The number and diameter of coils on 10cc syringe were calibrated and designed to generate an appropriate vacuum to aspirate the cortex without causing the inadvertent collapse of the anterior chamber. The stainless-steel spring with 12 coils has a width of 1.8 cm, length of 7.6 cm, coil thickness of 1.5 mm, and an inter coil distance of 9 mm. On the contrary, using a 10cc syringe with a conventional Simcoe is difficult because of physical and dynamic constraints such as limitations in thumb movement and the need for additional pulling force to create an adequate vacuum [Video Clip 1].

Results

The VCR was used for cortex aspiration in 45 eyes of 45 patients, of which 30 underwent MSICS and 15 underwent phacoemulsification. Hydrodissection was performed in all cases except in posterior polar cataracts, where hydrodelineation was performed. No complications, including posterior capsular rent or zonular dialysis, were witnessed due to the VCR-assisted cortex aspiration. Dry aspiration using

VCR was performed in two patients where a posterior capsular rent was noted after nucleus delivery. Inadvertent iris catch was noted in five patients. Cortical clean-up was completed in a single attempt in approximately 90% of patients. Those patients who had a large chunk of epinuclear sheet required a repeat aspiration.

Discussion

Vacuum-assisted cortex aspiration is different from the traditional Simcoe in that the necessary vacuum is produced by the relaxation of the spring, which pushes the plunger up, instead of manually retaining a constant pull over the plunger.

To date, there is no equivalent or comparable device to replace the time-tested Simcoe irrigation-aspiration cannula, which was developed nearly 40 years ago.[3] Various systems have been proposed for cortex aspiration in MSICS, including the O'Gawa's double-bore cataract aspiration needle, McIntyre needle, Gills cannula,[4] Simcoe's twin cannula with a squeeze bulb,[5] partially disposable coaxial system by fabricant,[6] and high-precision fingertip-controlled aspiration device.[7] However, none have eclipsed the Simcoe cannula. Consequently, numerous modifications have been suggested to the Simcoe cannula to improve its performance such as enlarging the aspiration port diameter from 0.3 mm to 0.4 mm,[8] altering the terminal segment of the cannula similar to a capsule polisher,[8] and having the double-barrel one behind the other instead of side by side.[9]

An ideal device for cortex wash should be simpler, safer, and not depend on expensive disposables.[9] It must also give the surgeon complete control of the vacuum with no after-suction residual vacuum and allow for the release of inadvertently aspirated tissue.

While using the traditional Simcoe cannula, beginners may be challenged by the need for bimanual coordination in addition to concentrating to retain a constant but controlled pull over the plunger of the syringe. It requires experience to understand how much manual pull is required to produce the necessary vacuum, which otherwise shall lead to inadvertent aspiration of the iris or capsule. This subjective variation increases proclivity for complications such as posterior capsular rent.

The VCR technique relies on the recoiling of the spring to create a gradual vacuum that allows the cortical material to be aspirated. The VCR provides a vacuum, which gives the surgeon the liberty to hold the syringe freely in a non-dominant hand and concentrate on cortex aspiration. There is a gradual decrease in the vacuum, which minimizes the risk of posterior capsular rent or collapse of the anterior chamber. Any inadvertently caught iris tissue or posterior capsule can readily be flushed out by pressing on the piston and expelling the aspirated contents. The rate of aspiration can also be manipulated by keeping a hold on the flange, limiting the relaxation of spring. The technique of "dry" aspiration of residual cortex done under the protection of viscoelastics in case of posterior capsular tears can also be performed using VCR.

As the spring is a detachable part made of stainless steel, it can be disassembled at the end of a procedure and can be autoclaved along with other instruments. It can also be sterilized with ethylene oxide and packed for use at a later time.

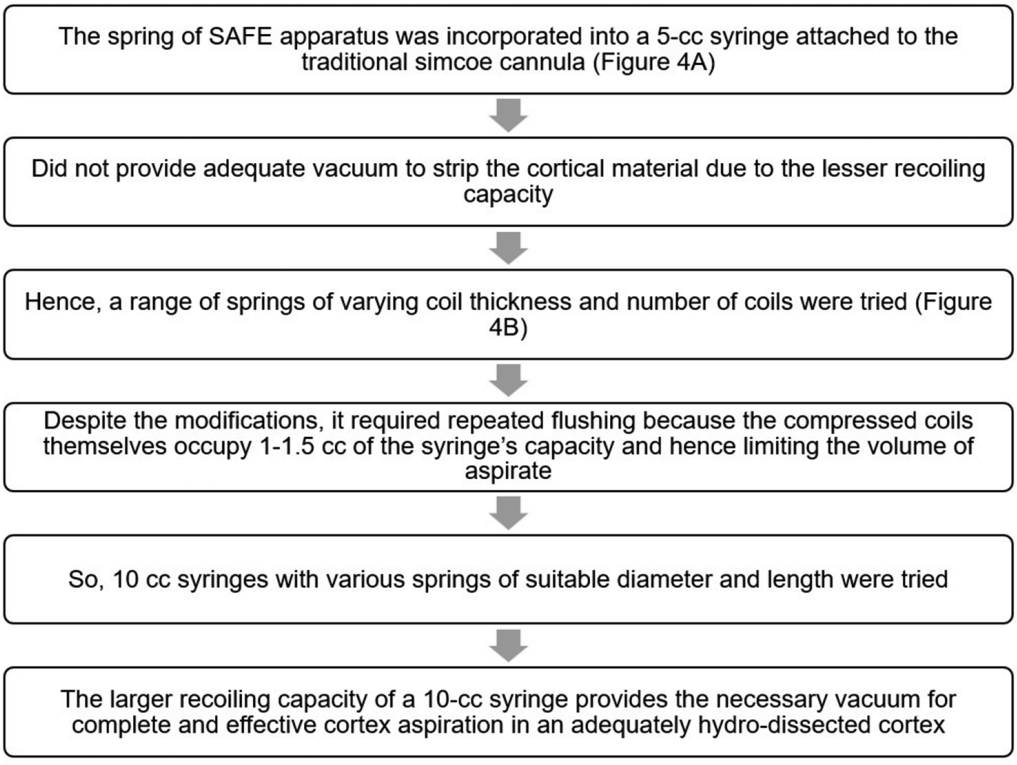

Figure 3: Flowchart showing the journey of creating the device

Figure 4: (a) Trial using a 5cc syringe. The thin coiled spring on a 5cc syringe inside the anterior chamber did not provide an adequate vacuum. (b) Springs of varying coil thickness and number of coils used for the trial

Caution should be exercised not to leave the flange of the syringe recklessly as it may lead to a sudden rise in vacuum and collapse of the anterior chamber. The use of a 10cc syringe provides the added advantage of aspirating a larger volume. Rarely, when repeated aspiration is required, the contents may need to be flushed out and the procedure needs to be repeated. Prior wet lab practice can aid in understanding the dynamic nature and amount of vacuum produced. With repeated use and autoclaving, a minimal variation may occur in the amount of vacuum generated, though we did not experience any significant change with the use of the device for 6 months. Further prospective studies comparing the surgeons' comfort and vacuum produced need to be conducted.

Conclusion

In conclusion, the VCR device can be a worthwhile addition to the armamentarium of devices available for irrigation and aspiration pending future validation research.

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Conflicts of interest

There are no conflicts of interest.

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